Fig.1

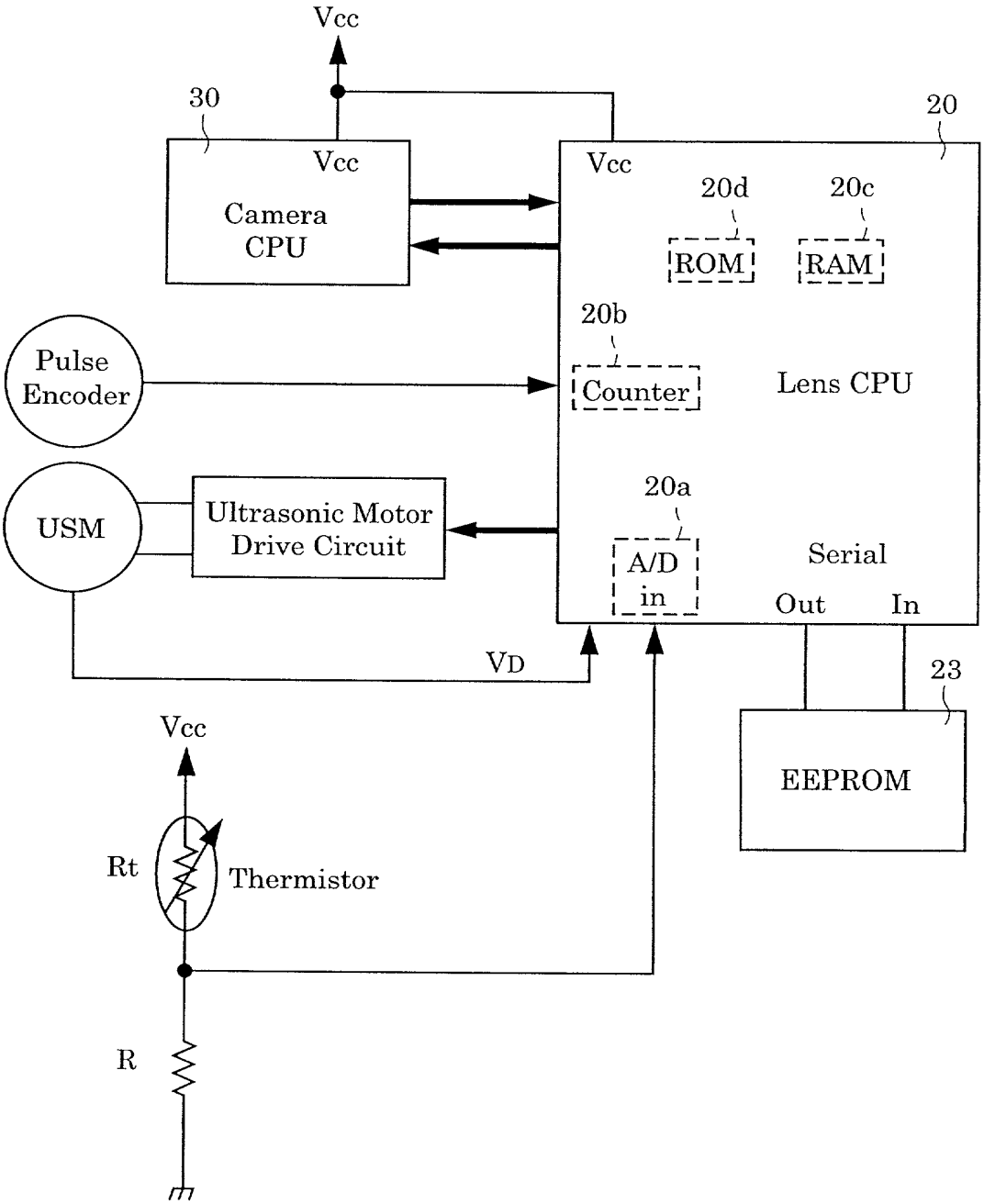

Vcc
30
Vcc
Camera CPU
20
Vcc
20d
20c
ROM
RAM
20b
Pulse Encoder
Counter
Lens CPU
USM
Ultrasonic Motor Drive Circuit
20a
A/D in
Serial
Out
In
VD
23
EEPROM
Vcc
Rt
Thermistor
R

Fig.2

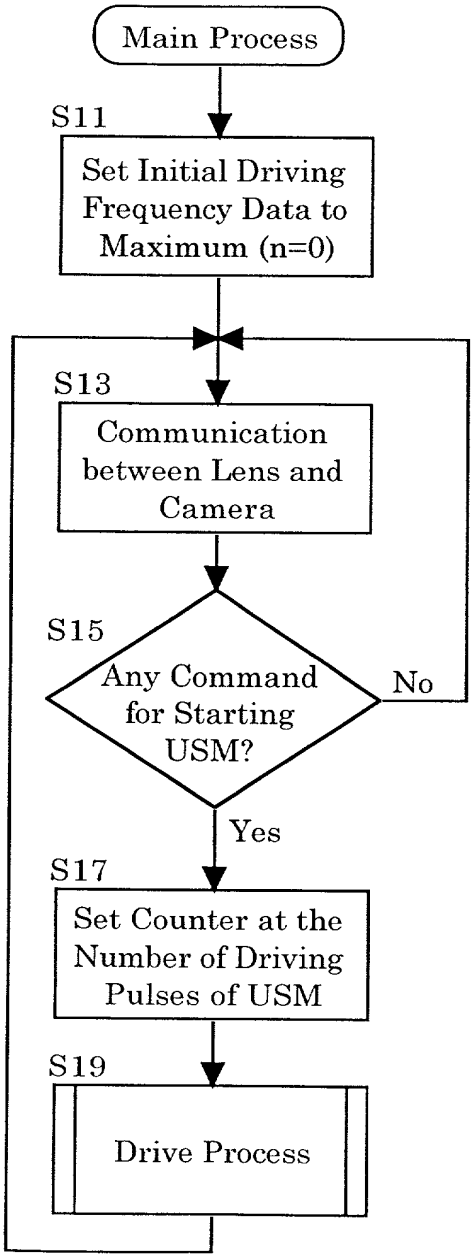

Main Process
S11
Set Initial Driving Frequency Data to Maximum (n=0)
S13
Communication between Lens and Camera
S15
Any Command for Starting USM?
No
Yes
S17
Set Counter at the Number of Driving Pulses of USM
S19
Drive Process

Fig.3

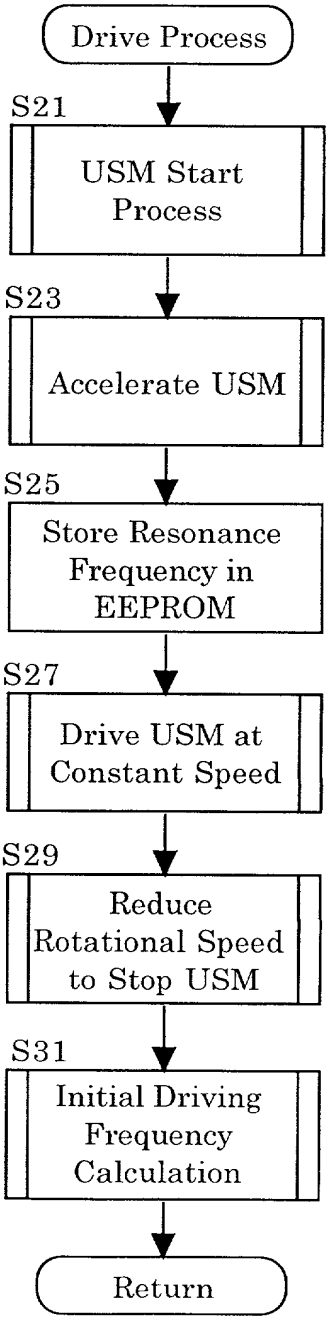

Drive Process
S21
USM Start Process
S23
Accelerate USM
S25
Store Resonance Frequency in EEPROM
S27
Drive USM at Constant Speed
S29
Reduce Rotational Speed to Stop USM
S31
Initial Driving Frequency Calculation
Return

Fig.4A

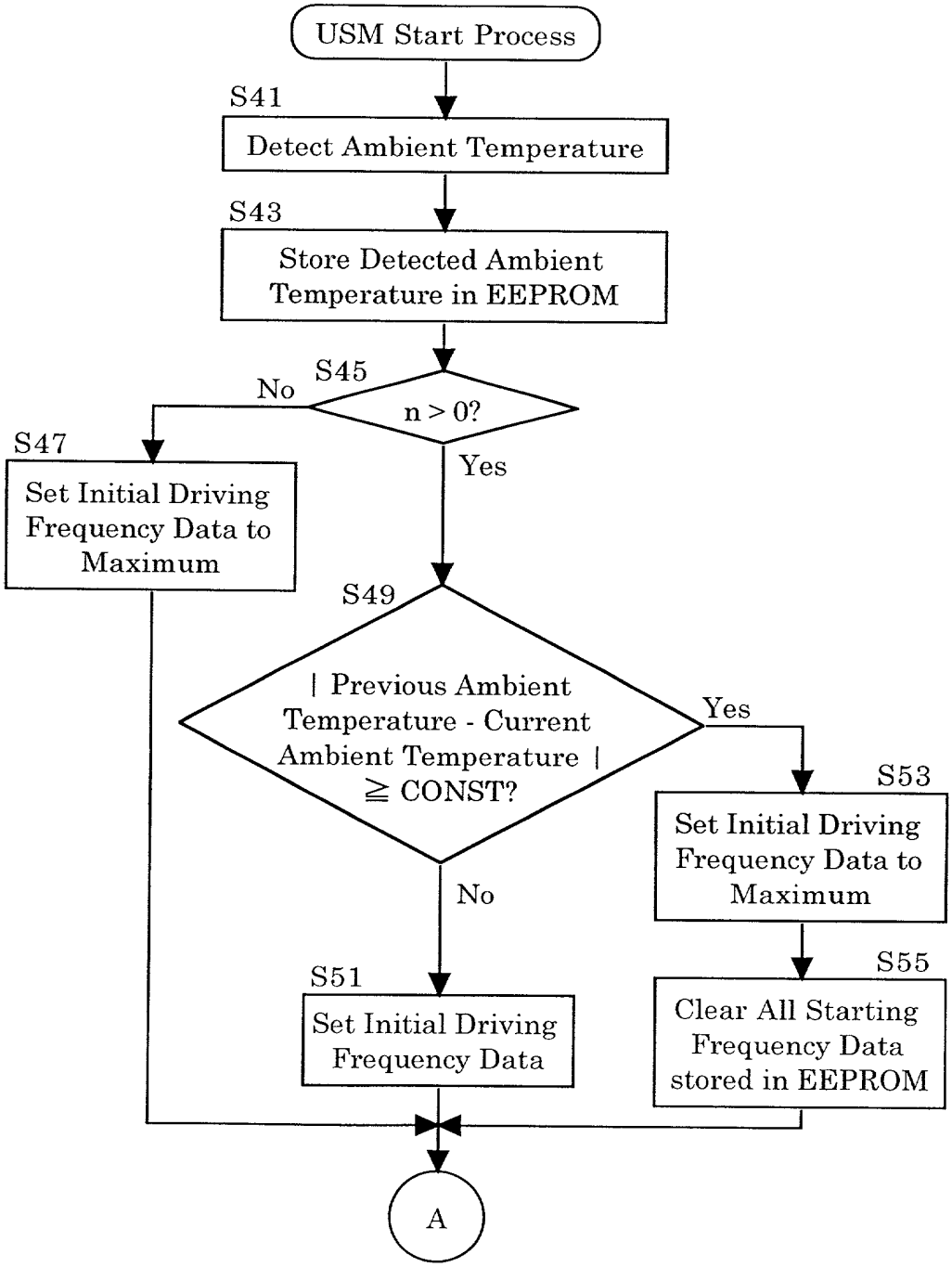
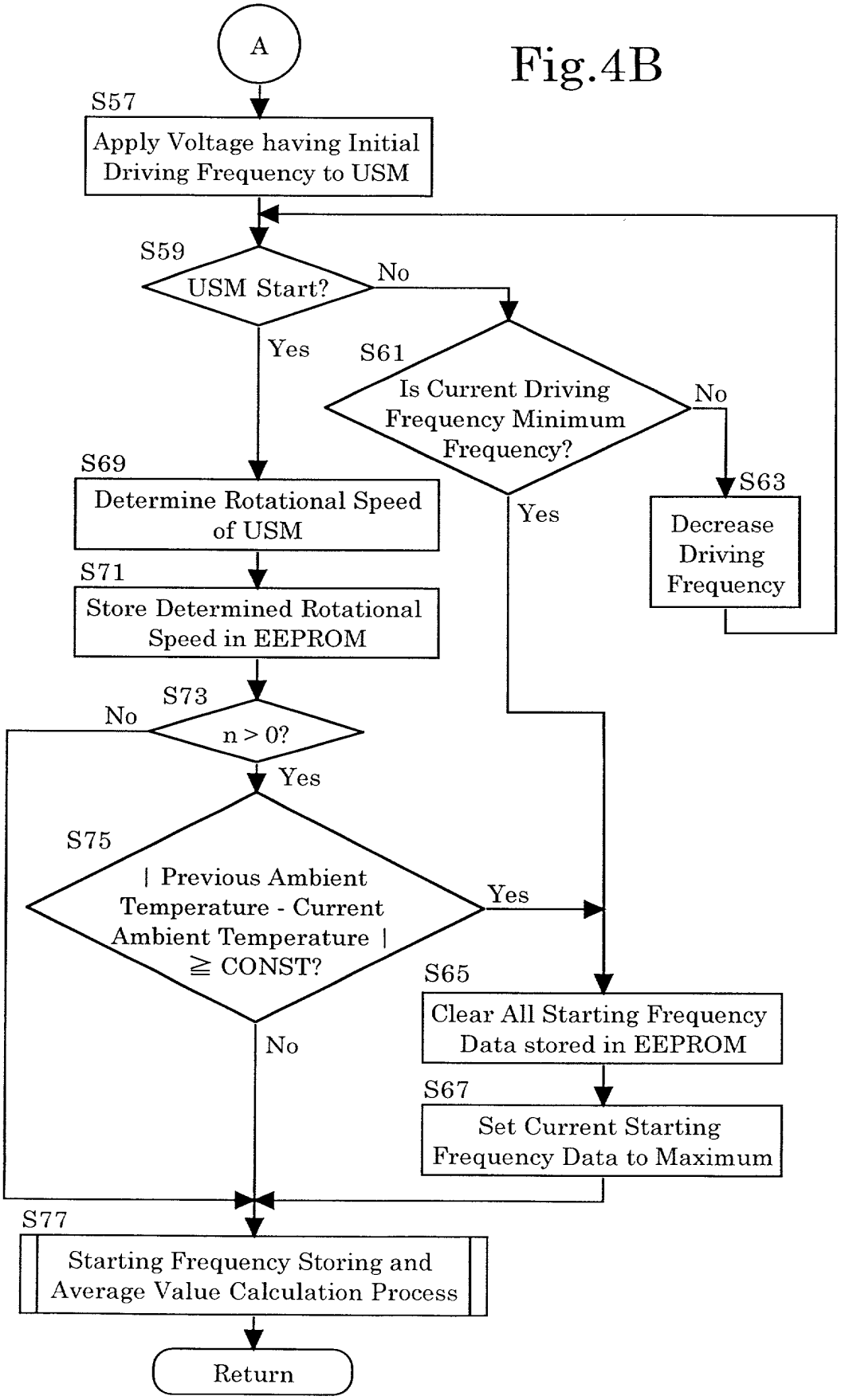

USM Start Process
S41
Detect Ambient Temperature
S43
Store Detected Ambient Temperature in EEPROM
S45
n > 0?
No
Yes
S47
Set Initial Driving Frequency Data to Maximum
S49
| Previous Ambient Temperature - Current Ambient Temperature | ≧ CONST?
Yes
No
S53
Set Initial Driving Frequency Data to Maximum
S55
Clear All Starting Frequency Data stored in EEPROM
S51
Set Initial Driving Frequency Data
A

Fig.4B


A
S57
Apply Voltage having Initial Driving Frequency to USM
S59
USM Start?
No
Yes
S61
Is Current Driving Frequency Minimum Frequency?
No
Yes
S63
Decrease Driving Frequency
S69
Determine Rotational Speed of USM
S71
Store Determined Rotational Speed in EEPROM
S73
n > 0?
No
Yes
S75
| Previous Ambient Temperature - Current Ambient Temperature | ≧ CONST?
Yes
No
S65
Clear All Starting Frequency Data stored in EEPROM
S67
Set Current Starting Frequency Data to Maximum
S77
Starting Frequency Storing and Average Value Calculation Process
Return

20070° T6ChE00T

Fig.5

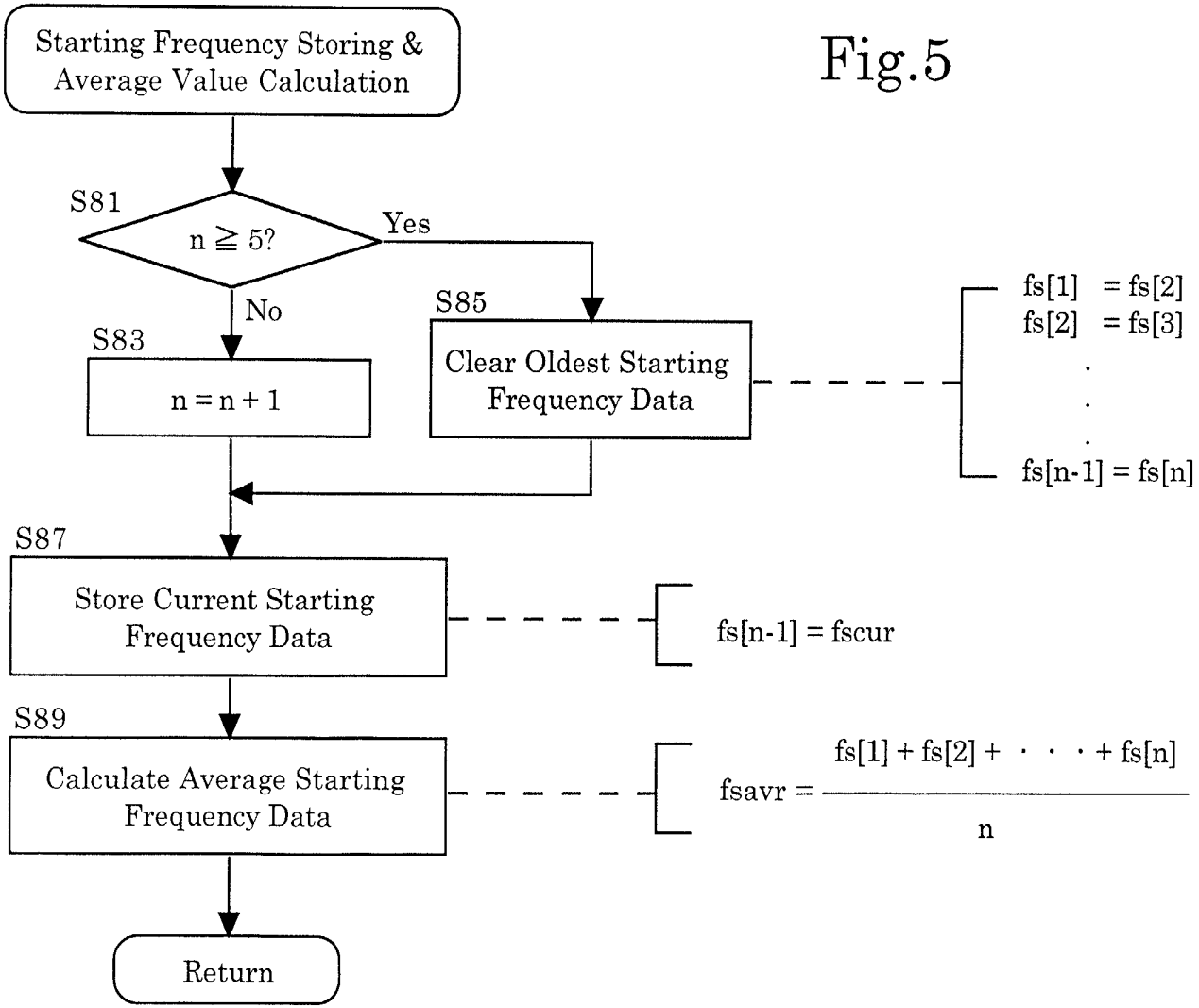


Fig.6

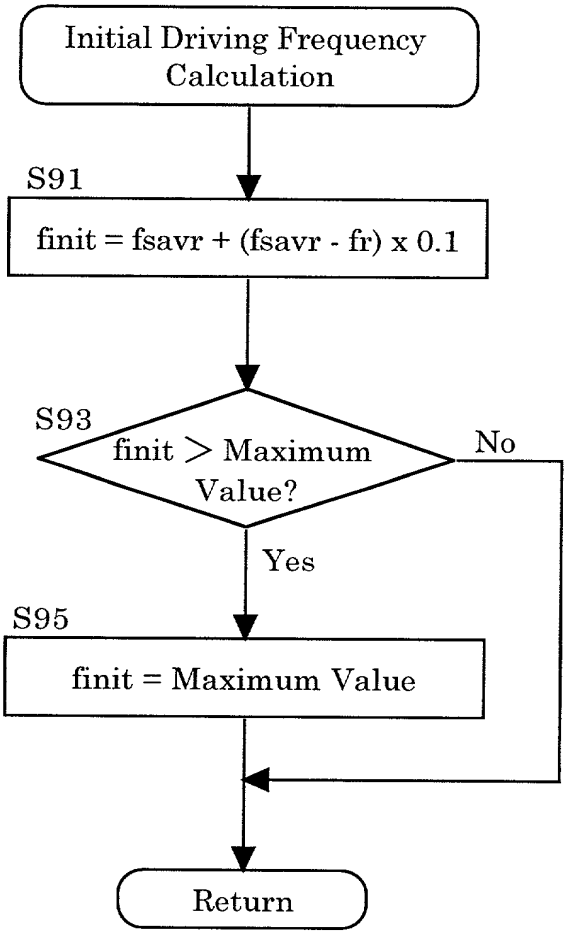

Initial Driving Frequency Calculation
S91
finit = fsavr + (fsavr - fr) x 0.1
S93
finit > Maximum Value?
No
Yes
S95
finit = Maximum Value
Return

Fig.7

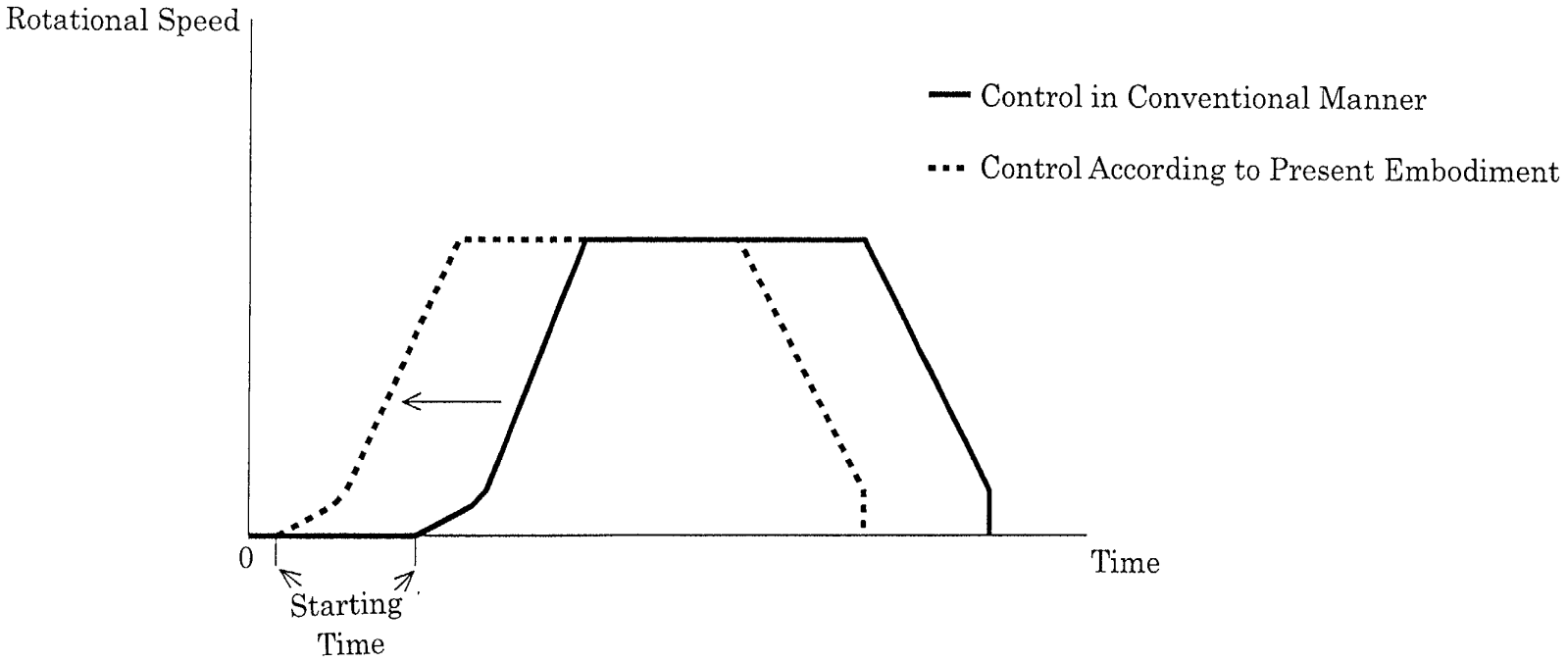

Rotational Speed
Control in Conventional Manner
Control According to Present Embodiment
0
Starting Time
Time

Fig.8A

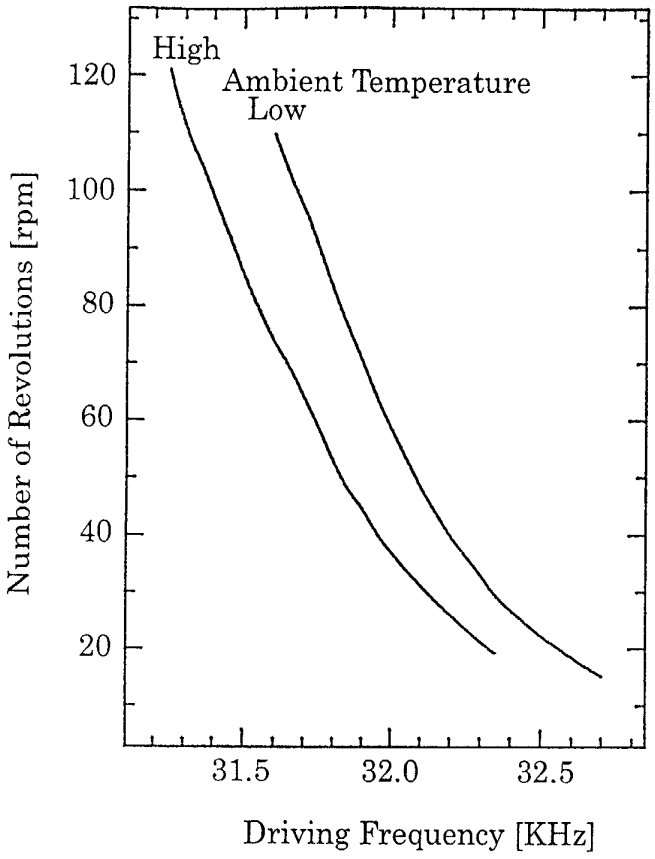

High
Ambient Temperature
Low
120
100
80
60
40
20
Number of Revolutions [rpm]
31.5
32.0
32.5
Driving Frequency [KHz]

Fig.8B

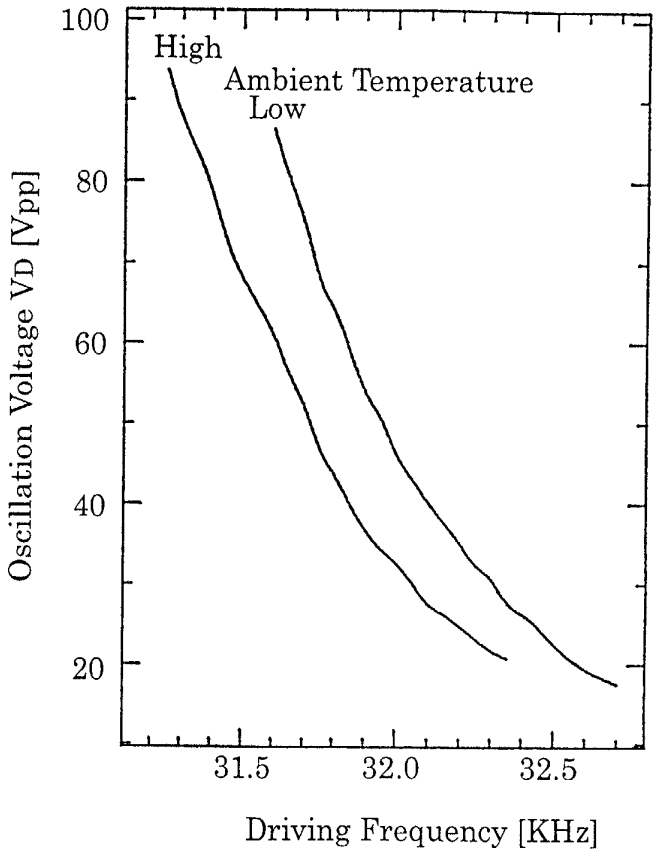

High
Ambient Temperature
Low
100
80
60
40
20
Oscillation Voltage VD [Vpp]
31.5
32.0
32.5
Driving Frequency [KHz]

Fig.9

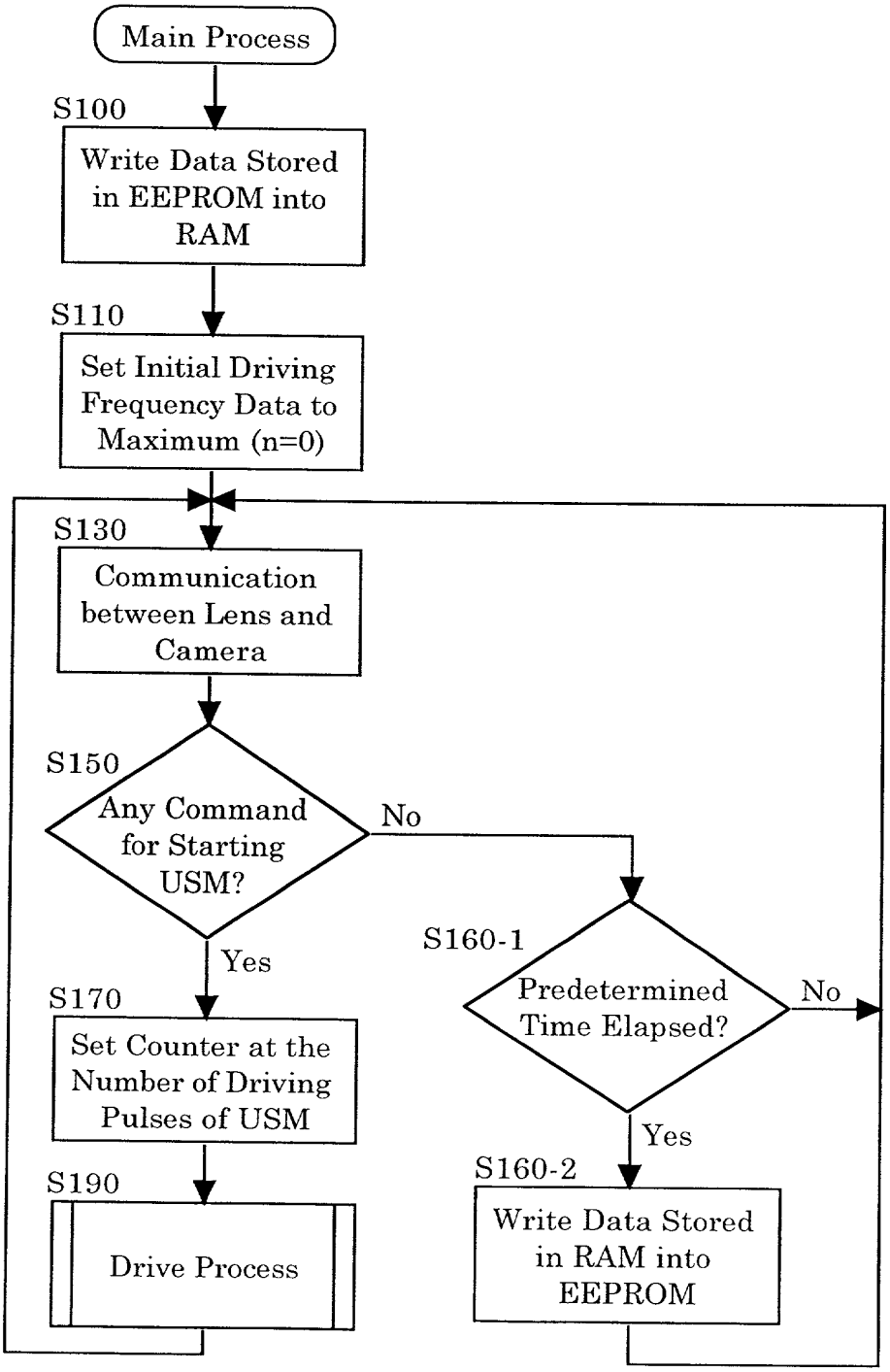

Main Process
S100
Write Data Stored in EEPROM into RAM
S110
Set Initial Driving Frequency Data to Maximum (n=0)
S130
Communication between Lens and Camera
S150
Any Command for Starting USM?
No
Yes
S160-1
Predetermined Time Elapsed?
No
Yes
S160-2
Write Data Stored in RAM into EEPROM
S170
Set Counter at the Number of Driving Pulses of USM
S190
Drive Process

Fig.10

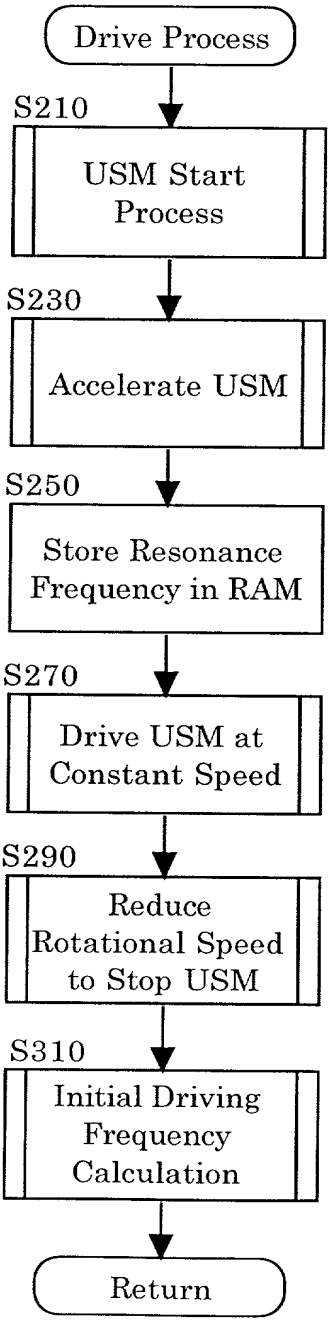

Drive Process
S210
USM Start Process
S230
Accelerate USM
S250
Store Resonance Frequency in RAM
S270
Drive USM at Constant Speed
S290
Reduce Rotational Speed to Stop USM
S310
Initial Driving Frequency Calculation
Return

Fig.11A

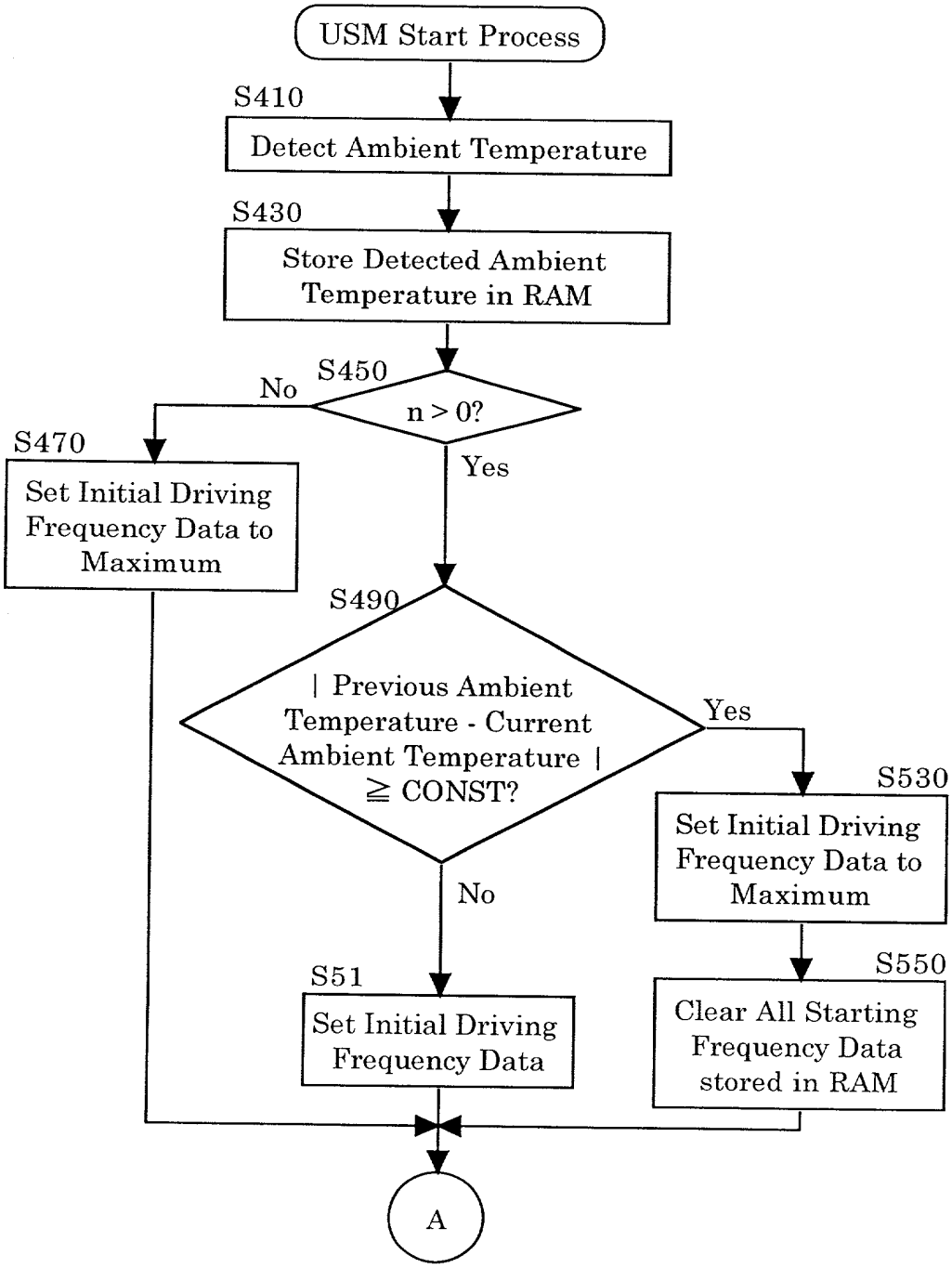
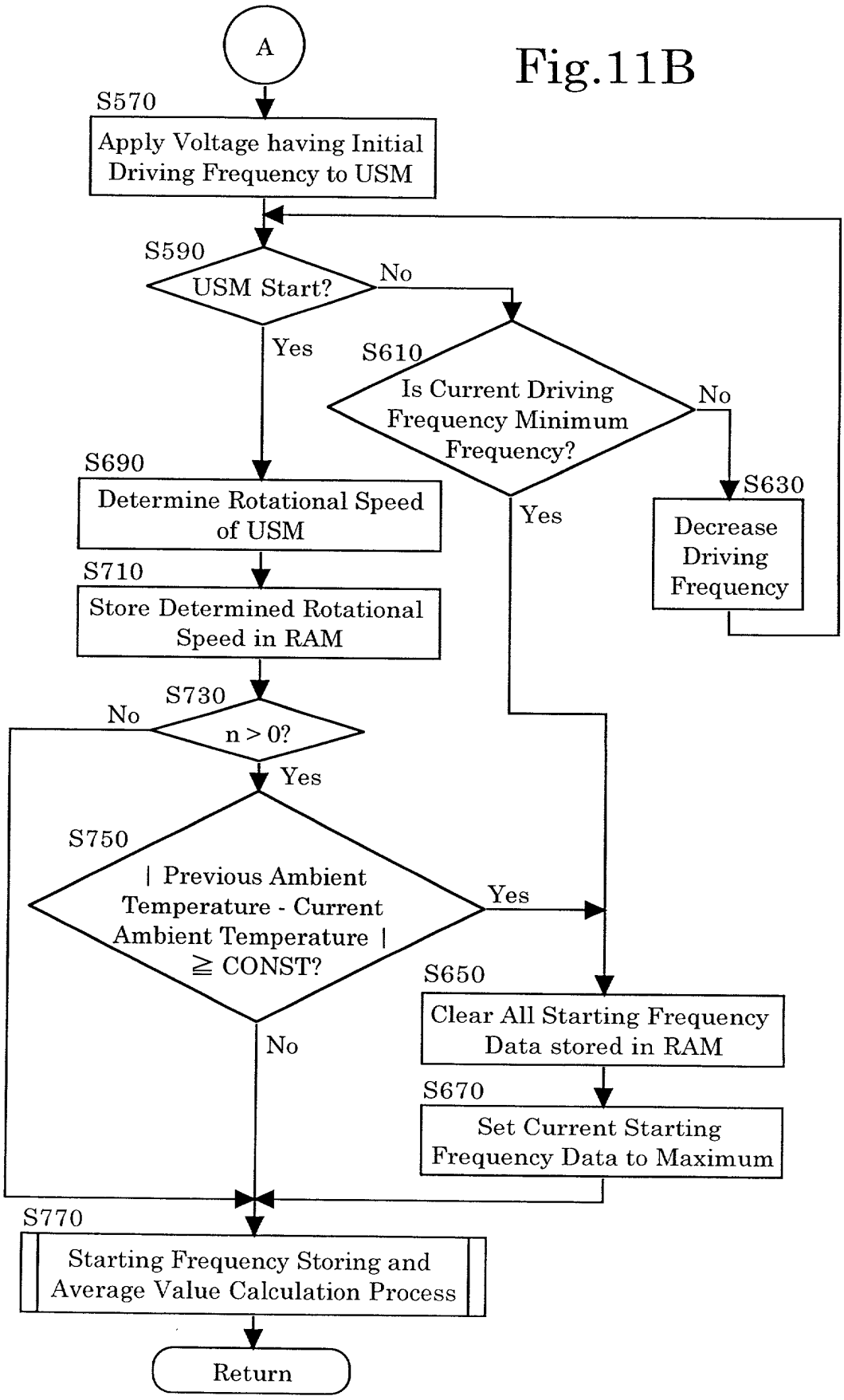

USM Start Process
S410
Detect Ambient Temperature
S430
Store Detected Ambient Temperature in RAM
S450
n > 0?
No
Yes
S470
Set Initial Driving Frequency Data to Maximum
S490
| Previous Ambient Temperature - Current Ambient Temperature | ≧ CONST?
Yes
No
S530
Set Initial Driving Frequency Data to Maximum
S550
Clear All Starting Frequency Data stored in RAM
S51
Set Initial Driving Frequency Data
A

Fig.11B


A
S570
Apply Voltage having Initial Driving Frequency to USM
S590
USM Start?
No
Yes
S610
Is Current Driving Frequency Minimum Frequency?
No
Yes
S630
Decrease Driving Frequency
S690
Determine Rotational Speed of USM
S710
Store Determined Rotational Speed in RAM
S730
n > 0?
No
Yes
S750
| Previous Ambient Temperature - Current Ambient Temperature | ≧ CONST?
Yes
No
S650
Clear All Starting Frequency Data stored in RAM
S670
Set Current Starting Frequency Data to Maximum
S770
Starting Frequency Storing and Average Value Calculation Process
Return